

# Smart container tracking: A sustainable path for modern port management

Aidonis D.<sup>1</sup>, Achillas Ch.<sup>1,\*</sup>, Tsolakis N.<sup>1</sup>, Fohinas D.<sup>1</sup>, Kotsoglou A.<sup>1</sup>, Tserga E.<sup>2</sup>

<sup>1</sup>Department of Supply Chain Management, International Hellenic University, 60100 Katerini, Greece

<sup>2</sup>Port of Thessaloniki, 54625 Thessaloniki, Greece

\*corresponding author:

e-mail: c.achillas@ihu.edu.gr

**Abstract** The rapid expansion of global trade and the increasing complexity of supply chains have highlighted the necessity for robust ICT solutions in modern logistics. Traditional methods of managing container movements are no longer sufficient to address inefficiencies, delays, and environmental concerns. In this context, ICT-driven systems enhance visibility while providing automated processes and enabling better-informed decision-making. These technologies not only streamline operations but also contribute to sustainability by optimizing resource utilization and reducing emissions. As ports become critical hubs in global commerce, the adoption of ICT solutions is essential to the effort to meet the growing demands for efficiency, transparency, and environmental stewardship. To that end, the ORA digital platform presents a pioneering solution for optimizing container logistics at port terminals by leveraging IoT technology and advanced data analytics. ORA integrates GPS-enabled devices, sensors, and API calls to provide real-time visibility and operational insights, enhancing environmental and logistical performance. ORA's interactive dashboard allows stakeholders to visualize container movements and analyze operational statistics. This data-driven approach reduces operational inefficiencies and minimizes the environmental impact of container logistics. Through combining cutting-edge IoT infrastructure with robust data visualization tools, ORA offers a transformative framework for modernizing port operations and contributing to sustainable trade practices.

**Keywords:** Smart Container, IoT, Operations Optimization, Data-driven Decision-making, Port Management.

## 1. Introduction

In today's interconnected global economy, efficient logistics management is paramount to sustaining the flow of goods across international supply chains (OECD, 2024). The growing volume of maritime trade and rising environmental concerns have intensified the need for innovative solutions that enhance operational efficiency while reducing ecological footprints (European Environment Agency, 2025). While digital transformation has revolutionized many industries, port terminals—critical nodes in global trade—often still rely on outdated

processes, leading to inefficiencies, delays, and unnecessary emissions (Almeida, 2023). Emerging information and communication technologies (ICT) present a significant opportunity to address these challenges by enabling real-time tracking, automation, and data-driven decision-making (Comi and Russo, 2022; Russo and Musolino, 2021). This paper explores the role of advanced ICT solutions in optimizing container logistics, focusing on sustainability and operational performance. Specifically, we examine the ORA digital platform, an IoT-based system that integrates real-time data analytics, sensor networks, and interactive dashboards to improve visibility and efficiency in port operations. By leveraging these technologies, ORA streamlines container movements and supports greener logistics practices, offering a scalable model for modernizing port terminals in an era of increasing environmental and logistical demands.

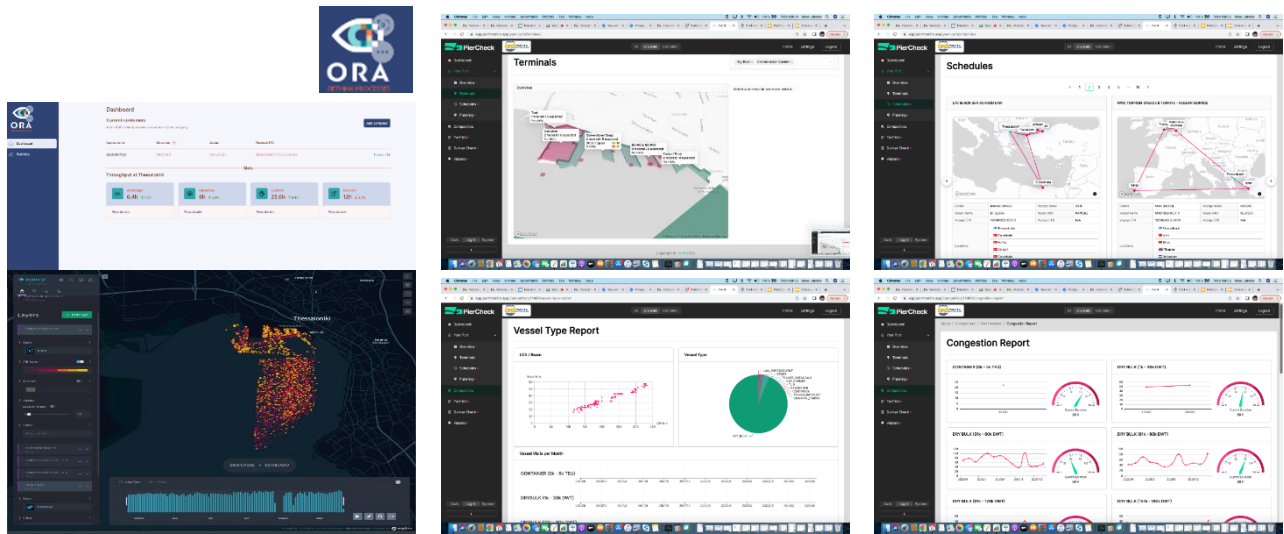
## 2. The ORA platform

The ORA (Online Real-time Analytics) platform is an innovative, web-based system designed to enhance visibility, security, and operational efficiency in the logistics and maritime sectors. Developed as part of the Internet of Containers (IoC) project (IoC project, 2025), ORA enables real-time tracking and monitoring of freight containers using IoT-enabled devices and geospatial technologies. Through its intuitive dashboard, users can access detailed information about container status, location, environmental conditions (e.g., temperature, humidity), and movement history. The platform supports role-based access for stakeholders such as port authorities, logistics providers, freight forwarders, and end customers.

ORA integrates geofencing capabilities for event-based tracking within specific zones (e.g., port terminals) and provides automated alerts for incidents like unauthorized container access, route deviations, or abnormal conditions. In addition to real-time data visualization, ORA offers advanced data analytics to support decision-making, operational planning, and compliance reporting. ORA's modular design allows for scalability, multi-port deployment, and API integration with external systems. By

improving supply chain transparency and minimizing delays or losses, the platform contributes to intelligent and sustainable logistics operations. ORA is particularly suited for use in ports, export hubs, and multimodal logistics

centers, supporting efficiency and regulatory alignment in a globally interconnected transport environment. Figure 1 presents indicative screenshots of the ORA platform's functionalities.



**Figure 1.** The ORA digital platform

### 3. Results and discussion

The pilot implementation of the ORA platform at the Port of Thessaloniki demonstrated notable improvements in operational visibility, container traceability, and data-driven responsiveness. Across three real-world scenarios, namely monitoring inland container transport, temperature control during transit, and unauthorized door opening detection, the system effectively captured and transmitted over ten thousand sensor signals, achieving GPS accuracy below three meters and alert response times under four minutes. Stakeholders benefited from real-time dashboards, automated alerts, and geofencing functionalities, which enhanced situational awareness and supported rapid intervention.

Integration with existing port systems (e.g., TOS, AIS, gate management) further enabled a unified logistics management environment. User feedback indicated high satisfaction with the platform's usability and visualizations. ORA's technical robustness, coupled with its modular architecture, underscores its scalability across other logistics nodes.

### 4. Conclusions

The pilot deployment of the ORA digital platform validated its potential to transform port logistics through real-time monitoring, automated alerts, and integration with legacy systems. The system improved traceability, operational efficiency, and security across diverse use cases, while maintaining high data quality and reliability. User feedback confirmed its practicality and added value in day-to-day operations. The platform's modular and scalable design makes it suitable for replication in other ports or multimodal hubs. By aligning with sustainability and digitalization priorities, the digital platform offers a forward-looking solution for modern logistics management and resilient supply chain operations.

### Acknowledgements

This work is funded within the framework of the Operational Programme "Central Macedonia" of the PA 2014-2020, Innovative Investment Plans, and co-financed by the Greek State and the European Union and, in particular, by the European Regional Development Fund (ERDF) (project code: KMP6-0273918).

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